

February 2, 1996

1.0 Introduction

In this report Sal Cicchelli describes a MODIS mechanical qualification matrix, Gerry Godden provides interpretations and questions regarding Al De Forrest's action item response email message on the scan mirror temperature sensor, Mitch Davis provides information on electronics telecon with SBRS on January 29, and Marvin Maxwell has recommendations on redundancy testing & calibration of MODIS.

2.0 Sal Cicchelli (MODIS Mechanical Qualification Matrix)

Author: Sal Cicchelli <scicchel@div720.gsfc.nasa.gov> at Internet

Date: 1/25/96 10:44 AM

Subject: MODIS Mechanical Qualification Matrix

----- Message Contents -----

The purpose of this memo is to begin summarizing information for reviewing and determining the extent to which the protoflight MODIS instrument has been mechanically qualified for flight (i.e. statically ,including thermal loads, and vibro-acoustically).

Currently, there exists no summary matrix which tracks every component on MODIS with regard to mechanical properties (estimated life, natural frequency. etc.),and what mechanical analyses and tests have been performed relative to an initial baseline plan. Establishing such a matrix, in my opinion ,is critical to evaluating the risk of instrument mechanical failure, and is my ultimate goal here.

In this memo will also be discussed the Fold Mirror failure and ATA component failures within the context of mechanical qualification.

I. BASELINE SPECIFICATIONS

The following is what I understand to be the contractual baseline specifications for instrument qualification:

A. EOS specified inputs at the MODIS/ EOS interface:

1. static proof loads: (x,y,z): (12.7, 9.8, 9.8)g's. These include the 1.4 factor of safety on ultimate and were separately applied as sine bursts in the MTM test. Ref: SBRC Report " Mass Loaded Mainframe Vibration Test Report ", GSFC # 2192, early 1995, p. 2.
2. random vibration qual level: 5.6 g rms Ref: Performance Verification Plan, p.138; Acceptance level: 4.4 g RMS p. 139. There is no notching in either of these curves.
3. a. (high level) SINE (sweep) design levels: sweep rate: 2 or 4 octaves/min

x		y&z	
freq.(Hz)	accel(g)	freq.(Hz)	accel(g)
5	.639	5	.639
8	1.5	9	2.0
15	1.5	17	2.0
15	2.5	17	3.5
35	2.5	30	3.5
35	1.0	30	2.0
50	1.0	50	2.0

Ref: "Sine Vibration Proposed Levels": FAX from R. Weber to L Candell; April 22,1993

b. (high level) SINE (sweep) test levels:

Ref: SBRC memo " MODIS - Structural Impacts of GIIS Change 4", GSFC # 2182,2-17-95. p.3.

Note: SBRC's current Test Plan Matrix (Ref. Performance Verification Plan, p.22), does not include a test for this at the mainframe level.

4. Modal Survey: Ref: Performance Verification Plan, p.34

5. Acoustics: Ref: Performance Verification Plan, p.36

6. Shock: no requirement at EOS/MODIS interface; will be done at EOS level (Ref. Performance Verification Plan. p. 168). SUGGESTION: There should be an SBRC analysis which predicts that the instrument is good for the shock level (to be derived) from
GSFC 420-03-02.

7. The test strategy is to test components at acceptance levels and test the full up instrument at qualification levels. Ref: SBRC Handout " Vibration Testing of MODIS Hardware", Weinstein.

8. Test Temperature limits: 60 degrees C to minus 40 degrees C Ref. SBRC memo " Environmental Test Mainframe", GSFC # 1980, 8-17-94.

B. SBRC Derived Specifications for MODIS components:

1. (high level) SINE (sweep): A series of memos by Tom Wolverton applies this spectrum to the SBRC NASTRAN model and determines g's at each subcomponent. The maximum component response is 60 g (without notching) and 19 g (with notching).
Ref: SBRC memos GSFC # 2078,11-18-9 2107,12-14-94; 2217,12-15-94; 2112,12-21-

94; 2147,1-19-95; 2183,2-19-95) There is a question here as to whether there is a real qualification test being done if the SINE input is notched.

2. random vibration: Reference SBRC document 152450. These curves are derived by a combination of SBRC NASTRAN results and GEVS. These curves are notched.

There appears to be at least one problem with using the SBRC NASTRAN model to derive these curves: the model is unverified. The MTM lowest natural frequency was about 42 Hz (with linear CRES mounts) , the 1995 SBRC modal survey (with linear flex mounts) result was 50 Hz, and with nonlinear titanium flight mounts the result was " in the 60's " Hz. The NASTRAN model (which is linear and does not incorporate flight mounts) predicts about 75 Hz. Model results such as g's and stresses are questionable for enveloping expected flight configuration loads and stresses until models are adjusted using test results and the relationships between model results and expected flight loads are clarified. A final decision on MODIS flight mount configuration is a part of this evaluation.

Also, when using NASTRAN models to justify notches, there should be a run for unnotched qualification inputs in addition to unnotched acceptance inputs at the mainframe, as was used in Tom Endo's memo of Jan 2, 1996 " AOA Random Vibration Notch Rationale" . It is not clear that notch derivation assumptions the acceptance level are valid for the qualification levels. Notch verification rationale using test (including acoustics) data needs to be discussed too.

C. Test Plan Matrix

Ref. Performance Verification Plan , p. 22.

II. FOLD MIRROR FAILURE

A. The test strategy derived for the penalty test(s) of the Fold Mirror seems to be a good blueprint for addressing component failures. The strategy is basically :

1. do the penalty test at the lowest component level, if feasible, to conserve life in other components.
2. use accelerometer data (not NASTRAN models) to derive the component input levels. Have stress analyses that show that the component is good for all planned loads.
3. do a penalty sine burst QUALIFICATION at the component level in addition to a rerun of the random acceptance, as an additional risk filter instead of waiting for the full up instrument qualification test, where a failure may be more difficult to deal with. One to three total sine burst cycles are allowed on the component (Ref. Performance Verification Plan. p.33).

In addition, regardless of whether a component fails or not, I suggest doing sine burst qualification at component level where there is an adhesive bond involved or where the required qualification level exceeds the (12.7, 9.8, 9.8) g equivalent single axis sine burst level (TBD for each component per SBRC memo " MODIS - Structural Impacts of GIIS Change 4, GSFC # 2182, 2-17-95, p. 2 par 5.) instrument levels; This conflicts with the Weinstein test strategy, but makes more sense from a risk mitigation point of view. There is no plan to do this SINE test at the instrument level.

B. Review of First Fold Mirror Test Plan

I re-examined the first Fold Mirror penalty test sine burst levels , and now suggest that there is no reason to subject any component to a static proof load greater than the instrument level (12.7 , 9.8, 9.8)g's unless a verified NASTRAN analysis (or component SINE excitations from occur. Neither do I believe that there should be any sine burst loads to simulate a 3-Sigma random load level; this is likely an overtest. Both a random test and a sine burst test should be done since the nature of these loads is different.

Further, I suggest that there be frequent cursory inspections at suitable points in a test, and after signs of a failure, a test should be stopped and sufficient inspection and analysis done to get good confidence in the most likely cause of failure. One example: this is a description of part of the test history from SBRC memo " MODIS Aft Optics Assembly Acceptance Test ", GSFC # 2585, 10-30-95. " Midway through the X axis full level test, yellow dust was noticed collecting at the bottom of the contamination protection bag just below the NIR assembly. Presumably an optical element had worked loose during the test or possibly during the prior Z axis test. (There) was no indication that a lens had shattered therefore it was decided to continue to the Y axis and fully complete the test schedule ". Here, I believe that an obvious inspection point was passed up (" yellow dust was noticed ") ; this kind of approach is likely to compound the problem of identifying and fixing failures with minimum resources.

On another subject related to the fold mirror failure: I understand that the failed/reworked mirror is still being considered for use as flight hardware. I would urge that a new mirror be used for flight since there is no guarantee that the rework removed all crack starters, and in addition, this failed mirror has been subjected to a lot of loading cycles. I also understand that the mirror has some minor optical flaws.

III. ATA COMPONENT FAILURES

It is suggested that the same penalty test strategy for the Fold Mirror penalty test be used, along with the additional suggestions above.

Also, I have reviewed the associated random vibration notch waiver submitted by SBRC and will provide comments separately from this memo.

I would also suggest against using the chipped lens for flight since there is no guarantee that there is not a crack starter at the chip location.

P. S. 12/95 QMR Comments: When will we get all those nice photographs SBRC promised ?

3.0 Gerry Godden (Scan Mirror Temperature Sensor)

Author: godden@highwire.gsfc.nasa.gov (Gerry Godden) at Internet

Date: 1/29/96 9:44 AM

Subject: Scan Mirror Temperature Sensor

----- Message Contents -----

Mike:

Here are my interpretations and questions regarding Al De Forrest's action item response email message:

Al#1: The empirical data shows that it takes about 3 hours to achieve stabilization from room temp conditions to orbital simulation levels in the vacuum chamber (C-1 in Greg Hughes' lab).

G2#1: This is interesting but not very informative. It would be helpful to know what the bulk temperature change was in 3 hours. What were the sought for orbital simulation levels (and rates of change)?

Al#2: Perturbation of the measuring system after orbital conditions have been reached has caused a settling time of several minutes. The lag times have been very short.

G2#2: What kind of perturbation? Was this perturbation consistent with the predicted on-orbit temperature variations (magnitude and rate of change)? What is several minutes? How are lag times defined? What does very short mean?

Al#3: Ron Choo believes that orbital variations smeared out over the 90 minutes will result in very small differences between actual mirror temperature and that sensed by the temp monitor.

G2#3: I don't know what "smeared out" means here. I expect that the Scan Mirror bulk temperature will vary in a complex way with the spacecraft diurnal variations (approx. 34 minutes in spacecraft night, 66 minutes in spacecraft day time, 40 minutes looking at the night time earth, and 60 minutes looking at the day time earth). This will be difficult to accurately model/predict because it is difficult to measure the Scan Mirror thermal conduction via the motor bearings, etc. What is most important to us is accurate knowledge of the Scan Mirror temperature during the day mode. Presumably, at the start of the day mode the Scan Mirror will be at its coldest. The temperature rate of change

will probably be at its slowest at the beginning of the day mode (and going negative), and its fastest at the end of the day mode (and going positive). How soon into the day mode will the Scan Mirror temperature sensor produce an accurate reading, consistent with the System Engineering flow down requirements?

4.0 Mitch Davis (Telecon on January 29)

Author: Mitchell L Davis at 730

Date: 1/29/96 3:25 PM

Subject: Weekly report 1/29/96

----- Message Contents -----

Report from telecon on January 29, 1996

- SBRC has received 7 replacement MEM connectors and should receive 13 more by weeks end. The remaining connectors are scheduled to be delivered by 2/9/96.
- The first cards to receive the new connectors are the 3 FIFO CCAs and the Mechanism Controller CCA.
- The PS shut down during cold testing. The problem was traced to noise coupling from a input power cable to the test output cable. This should not affect the flight performance. Hughes Torrance was stopping the testing to add additional filtering on the test output circuits.
- The MEM is schedule to go to Vibration testing on 2/7/96. There is a schedule problem on what to due first between: testing the wiring/potting some wiring/ vibration testing.
- The EO to correct the SAM Bias noise problem has been written.
- The FAM PC_AMP CCA has a incorrect data output problem which has been traced to an area that was changed from EM to PFM.
- SBRC has decided to accept the remaining 5 Hybrids after the leads have been straightened and the seals have additional epoxy applied. The vendor has concerns with the number of "leak" test performed on the Hybrids. They believe that this testing may cause bowing in the IC due to the pressure which may have caused the original cracks and breaks.

5.0 Marvin Maxwell (Testing MODIS Redundancy)

Author: "Marvin Maxwell *" <MAXWELL@swales.com> at Internet

Date: 1/29/96 4:12 PM

Subject: Testing of MODIS Redundancy

----- Message Contents -----

I am not sending this directly to SBRC.. If you think it is satisfactory you may send it to SBRC for their information.

Subject: Redundancy Testing & Calibration of MODIS

Redundancy checking must consider both Functional Checks, which validate that the data flows properly through the system, and Performance Checks which validate that the MODIS meets its specified performance in all of the key different redundancy configurations. Because of the very large number of configurations that the MODIS can assume it is not reasonable to check all combinations for performance. It is essential to check that all of the cross strap paths between the various elements operate properly as validated by functional tests.

The redundancy options described are from Figure 10, MODIS Electronics Block Diagram in the MODIS Engineering Telemetry Description Update, CDRL 305 of April 1994.

The redundancy combinations that are most likely to affect calibration and performance, especially Signal to Noise, involve the SAM, FAM, Format Controller, Power Supply and the Timing Generator. The SRCA and SDSM may also be affected by changing their redundant electronics. Switching redundant elements in the SAM and FAM will probably have a significant impact on calibration and S/N performance. Redundancy selection in the Format Controller may affect S/N and possibly responsivity and calibration. Redundancy selection in the Timing Generator because of the AEM clocks going to the SAM & FAM may affect calibration and S/N. Redundancy selection in the Power Supply will probably only affect S/N but at least a 2 point check of responsivity should be done to validate this assumption.

Potential impact of Redundancy Switching On

Item	Performance, S/N	Calibration
SAM & FAM	High	High
Format Controller	High	Moderate
Timing Generator	Moderate	Low
Power Supplies	Moderate	Low

The four redundant elements in the SAM and the FAM can be individually selected for side A or B (or Off). Is it necessary, or desirable, to check for the operation switching each element individually? If so, what combinations should be tested. One possible combination would be:

Test
SAM,NIR SAM,VIS SAM,SWIR SAM,LWIR FAM,LWIR

1	A	O	O	O	O
2	O	A	O	O	O
3	O	O	A	O	O
4	O	O	O	A	O
5	O	O	O	O	A
6	A	A	A	A	A
7	B	B	B	B	B

Key: A = Side A on, B = Side B on, O = Off

The above sequence does not check most of the possible combinations. The tests Numbers 1 to 6 observe the changes in noise and responsivity as elements are activated. Test Number 7 establishes the noise and responsivity going to side B. If the performance of side B in test 7 is significantly different from side A it may be desirable to check the noise on side B elements alone similar to that in tests 1 to 5 for side A.

One possible set of test configurations to establish the Functional Cross Strap compatibility between most of the major elements in the MODIS follow: The tests are designed to test, if possible, all 8 combinations of input, output and power supply selection of each major element. The Timing Generator and Telemetry & Command Processors are interleaved in a manner considering their interconnections to the elements.

Test Number	1	2	3	4	5	6	7	8
SAMs & FAM		A	A	B	B	A	A	B
Format Controllers		A	B	A	B	A	B	A
FIFO Memories		M1	M2	M3	M4	M4	M3	M2
FDDI Formatters		A	B	A	B	A	B	A
Timing Generators		A	B	B	A	B	A	A
Scan Mirror Controllers		A	B	A	B	A	B	A
Telemetry & Cmd. Process		A	A	B	B	A	A	B
Power Supplies		A	A	A	A	B	B	B
Calibrator Electronics		A	B	A	B	A	B	A
Temperature Controllers		A	B	A	B	A	B	A
Mechanism Controllers		A	B	A	B	A	B	A
Survival Heaters		A	B	A	B	A	B	A

Key: M1 to M4 are the four redundancy modes of the FIFO memories.

During the Functional Testing there should be a continuous monitoring and assessment of the Noise, S/N and responsivity of the channels. This should not require any special equipment, other than the bench cooler, for the IR bands but may present a life problem for the SIS lamps to check responsivity stability in bands 1 to 20. It may be adequate to perform functional checkout of the SRCA and SDSM only 4 times during the testing using the A & B sides of the Calibrator Electronics with the A & B sides of the Power Supplies.

Calibration

Channels must be Calibrated on both the A and B sides of the SAM and FAM. It may be adequate to do a partial calibration, to show that there is no significant change, with both sides of the SAM & FAM and the A & B sides of the Format Controller. Enough data should be acquired and analyzed using the data from the Functional Cross Strap checking to show if there is any calibration sensitivity to Power Supply and/or Timing Generator redundancy switching.

MR

2/6/96